

Impacts of an urban water system investment on health, well-being and poverty

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Background

US MCC and GoT entered into a Compact to improve water quantity and quality in Dar es Salaam and Morogoro

Two components:

- Double capacity of Lower Ruvu treatment plant (Dar es Salaam)
- Rehabilitate water treatment plant and improve water transfer in Morogoro
- \$64.2 million investment; 2.8 million estimated beneficiaries

Estimated completion date mid-2014, but...

Background: Project objectives

Short-term

- Reduce water-related illness
- Lower time used hauling water
- Improve human capital accumulation (school participation and attendance)
- Decrease health/avoidance costs
- Lower costs of water
- Increase water security
- MCC is especially interested in impacts on sub-groups: women, children and the poor

Long-term

- Increase investment in human and physical capital
- Reduce water-related disease

Evaluation objectives

Document and measure impacts of investment on household well-being:

- Drinking water choice, consumption of water and consumption expenditures
- Time costs associated with collecting water
- Water-related morbidity and expenditures
- School participation and absences
- Water security
- Defensive actions/expenditures

Exploit variability in intensity of treatment

Baseline survey data available but intervention has not yet been completed; complete evaluation design includes a GPST in a difference in difference approach and use of structural (IV) econometric models

Treatment

Treatment is conceived of as changes in access to (quantity) & quality of water

Most evaluations of such investments in developing countries conceptualize treatment as a binary outcome (improved/unimproved)

- Investments in rural systems (evaluation is relatively straight-forward with matching methods)
- Do not account for continuous nature of water supply nor the reality that households obtain water from numerous sources

Urban Tanzania: households access system water through own-connections, water kiosks, neighbors; also access non-system water through boreholes, surface sources, water vendors, etc.

System capacity constraints will maintain spatial variability—water investments may alter portfolio of water sources

Challenges

Measuring treatment

- Water quality: at plant & household-level
- Access to water: Supply disruptions & low pressure
 - Initial plan: metering at strategic points...but...spaghetti supply networks...no tight DMAs...no reliable mapping of network available
 - Revised plan: cluster-level measures of supply availability—household survey & 3 rounds of follow-up telephone calls
 - Identification: Is exposure to the treatment endogenous?

Heterogeneity: three broad classes of households

- 1) Prior connection to water system (changes in quantity & quality)
- 2) Induced to connect (difference between prior and current)
- 3) Never connected (changes due to system water availability)

Delays in implementation

- Accelerated household survey in Morogoro
- Flushing the system: Measurement leads to improved supply!

Challenges: Methods for impact assessment

Generalized propensity score matching (Hirano and Imbens 2004)

- Conditional on baseline characteristics, expected outcomes for treatment and comparison groups are independent of the assignment
- Three-step process: (i) estimate the score $\{r(t,x)\}$; (ii) estimate conditional expectation of outcome as a function of the observed treatment level $\{T\}$ and the GPS R : $\beta(t, r) = E(Y | T = t, R = r)$; and (iii) estimate the dose-response function, $\mu(t) = E[\beta\{t, r(t,X)\}]$, $t \in T$, by averaging the estimated conditional expectation, $\hat{\beta}\{t, r(t,X)\}$, over the GPS at each level of the treatment.
- Few assumptions about structure of the relationship; embodies the idea that there is no control group (everyone with a connection is treated)
- Suitable for household group 1

Propensity score matching

- Group 2

Instrumental variables

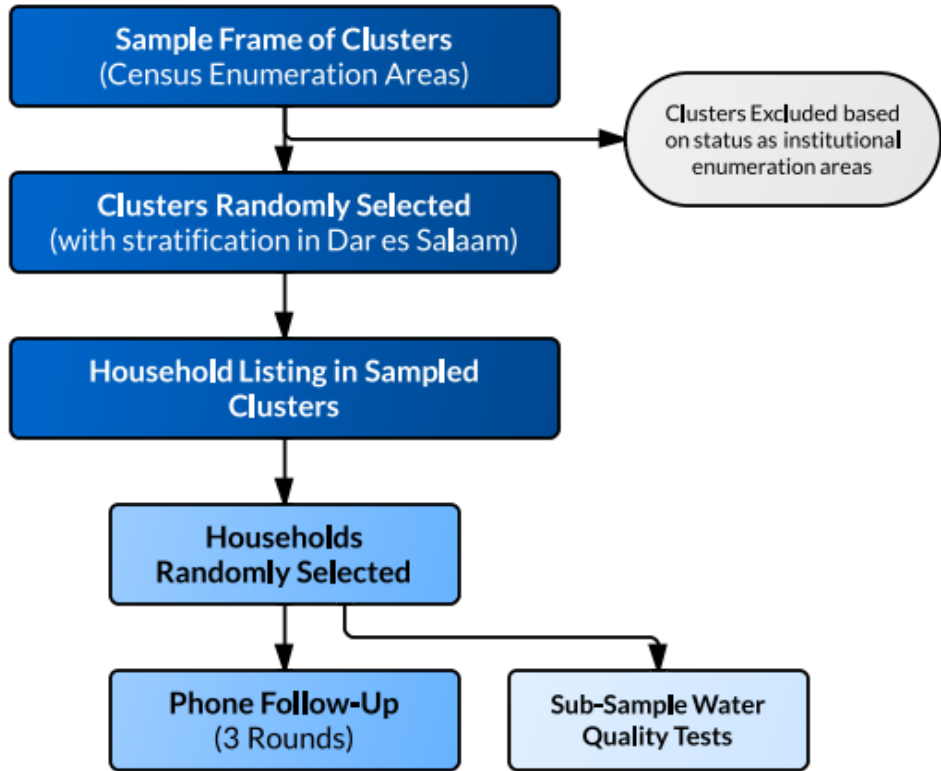
- “Selection on unobservables”
- Group 3, but also used as a check for other estimates
- Geospatial information on kiosk and main supply lines serve as instruments
- Detailed rainfall data during period prior to survey

Data Collection

- Listing: Mini-Survey
- Mini-Survey
- Listing: Full Baseline
- Full Baseline Survey

- Water Quality Tests
- Phone Survey (3 rounds)
- Qualitative Interviews
- Geospatial & secondary data collection

	April	May	Jun	Jul	Aug	Sept
Listing: Mini-Survey						
Mini-Survey						
Listing: Full Baseline						
Full Baseline Survey						
Water Quality Tests						
Phone Survey (3 rounds)						
Qualitative Interviews						
Geospatial & secondary data collection						



Household sample size:
 5,008 households surveyed from 626 census enumeration areas (clusters)

Electronic data collection by local firm, EDI, using Surveybe.

Focus of baseline survey analysis

Demand for water: choice of source and water expenditures

Burden of water collection: time and volume hauled

Water-related illness: under-5 diarrhea events

Water insecurity: Are “water shocks” important?

Outcomes

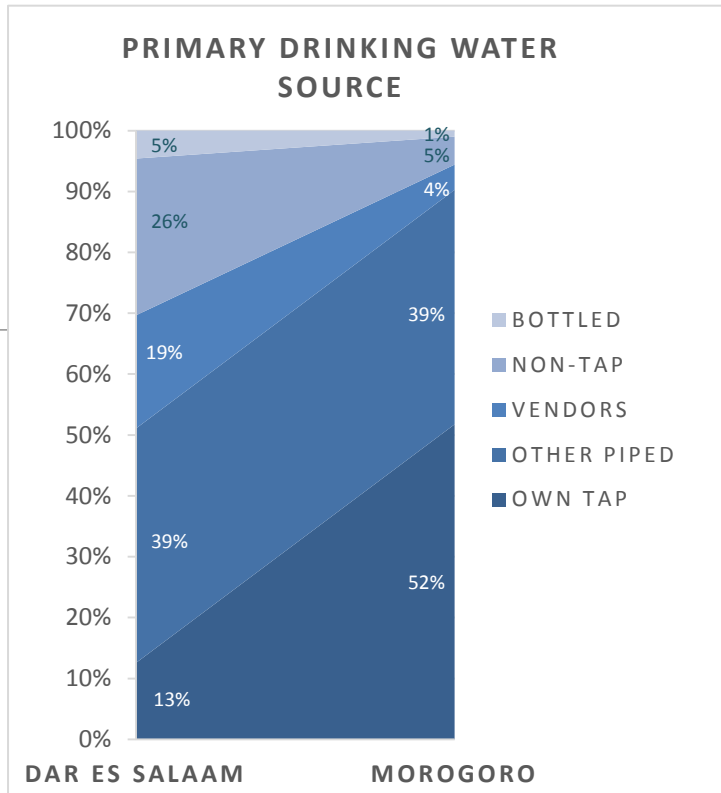
Impact on:

Water supply at the utility level

Demand for connections to network

Access to water and availability of water (household level)

Water quality (source, distribution channel, point of consumption)



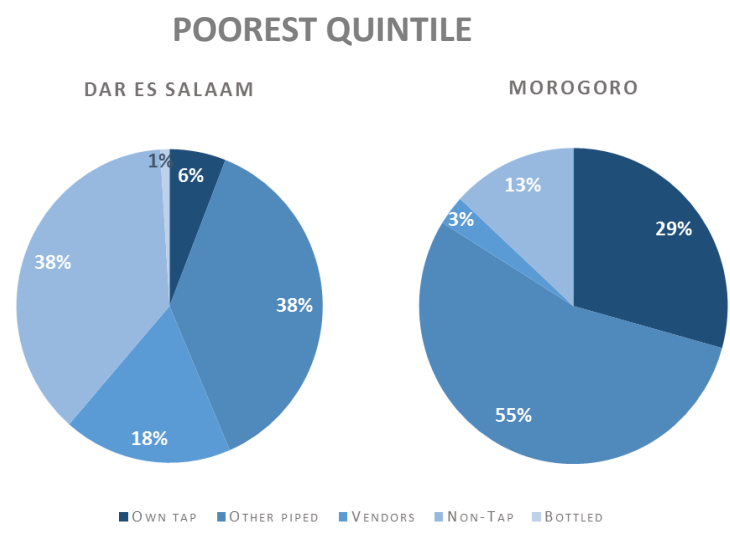
Households using, as primary source:

- Own tap on premises
 - 13% in Dar es Salaam
 - 52% in Morogoro
- Piped source (own tap, or other piped)
 - 52% of residents in Dar es Salaam
 - 91% in Morogoro

In Dar es Salaam, a fifth of the poorest households obtain drinking water primarily from vendors (3% in Morogoro).

~40% of the poorest in Dar es Salaam use a non-tap source for drinking.

Poor households are more likely rely on sources of lower quality & those that require more time and money (especially in Dar es Salaam).



Outcomes

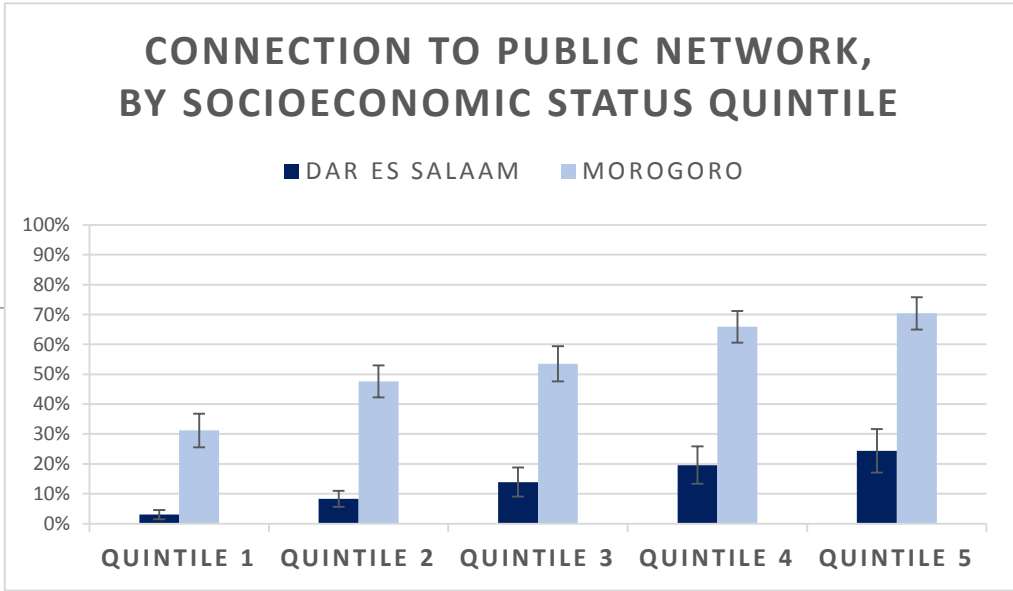
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But poorest may not necessarily benefit directly from the interventions.

The most immediate and direct benefits of the project are expected to go to those connected to the network.

Households of the lowest socioeconomic status have the lowest connection rates to public distribution network.

- Dar es Salaam: 3% of the poorest are connected to a public network tap, and 24% of the wealthiest.
- Morogoro: 31% of the poorest are connected, and 70% of the wealthiest.

Outcomes

Impact on:

Water source use by activity

		Dar es Salaam			
Water Source	Drinking	Cooking	Washing	Cleaning	
Own tap	15%	17%	17%	17%	
Other piped	51%	52%	51%	51%	
Vendors	29%	25%	24%	23%	
Non-Tap	39%	57%	64%	65%	
Bottled	12%	2%	1%	1%	
Other	1%	1%	1%	1%	
		Morogoro			
Water Source	Drinking	Cooking	Washing	Cleaning	
Own tap	57%	58%	58%	58%	
Other piped	52%	52%	51%	51%	
Vendors	8%	8%	7%	7%	
Non-Tap	25%	30%	36%	36%	
Bottled	6%	0%	0%	0%	
Other	2%	2%	2%	2%	

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In Dar es Salaam, non-tap sources are most frequently used for all activities other than drinking, followed by other piped sources.

In Morogoro, water from a tap on premises is most commonly used for all activities, with other piped sources next, and non-tap sources third.

- Reflects higher connection rates in Morogoro.

Since intervention aims to improve supply through the public network, changes in the overall portfolio and ranking of various sources will be assessed baseline to end-line.

Statistical analysis modeling demand for piped water

1. Determinants of having a tap on premises
2. Determinants of choice of main source of drinking water

1. Determinants of having a piped source	2. Determinants of main drinking water source
<p>Neighborhood effects are most influential:</p> <ul style="list-style-type: none"> • Probability of having tap connection increases by 5.2% in Morogoro and 5.8% in Dar es Salaam, for each additional connected household in the neighborhood. • Household composition and housing characteristics not statistically significant factors when the neighborhood effects are considered. <p>This suggests that use of piped water sources is mainly constrained by supply factors.</p> <p>Efforts to make piped water more available (e.g., through increased connection rates) likely to increase use substantially.</p>	<p>Socioeconomic status most influential:</p> <ul style="list-style-type: none"> • Wealthiest >10% more likely to use tap compared to poorest • Households with best-educated adult completing primary school, are 36% less likely to use surface water <p>Wealthier households more likely to benefit directly from an expansion in supply of tapped water through own tap; poorer households may benefit indirectly (at least at first).</p>

Objectives

Impact on:

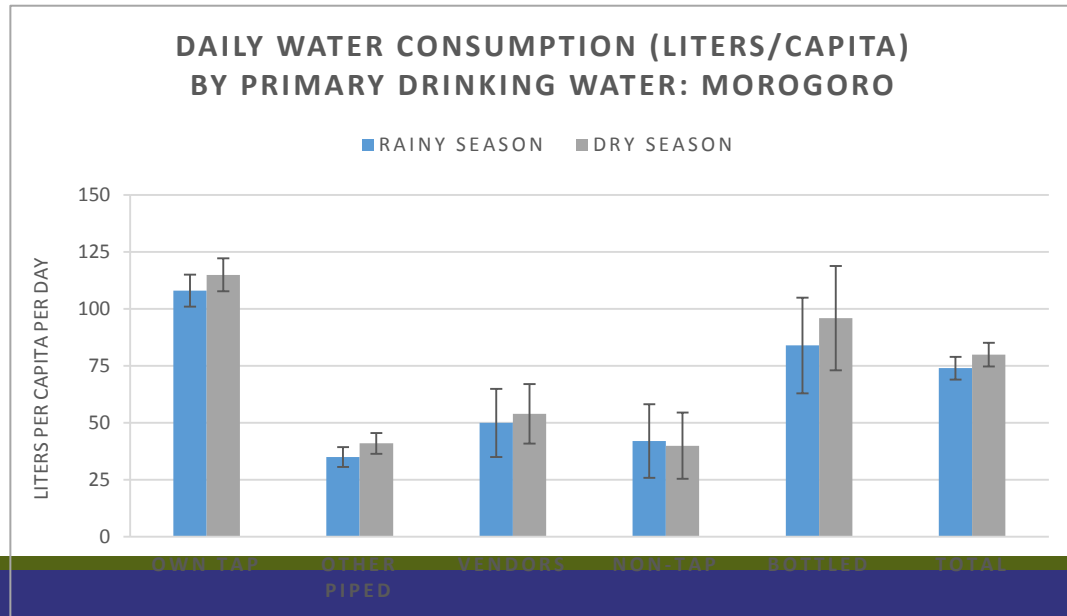
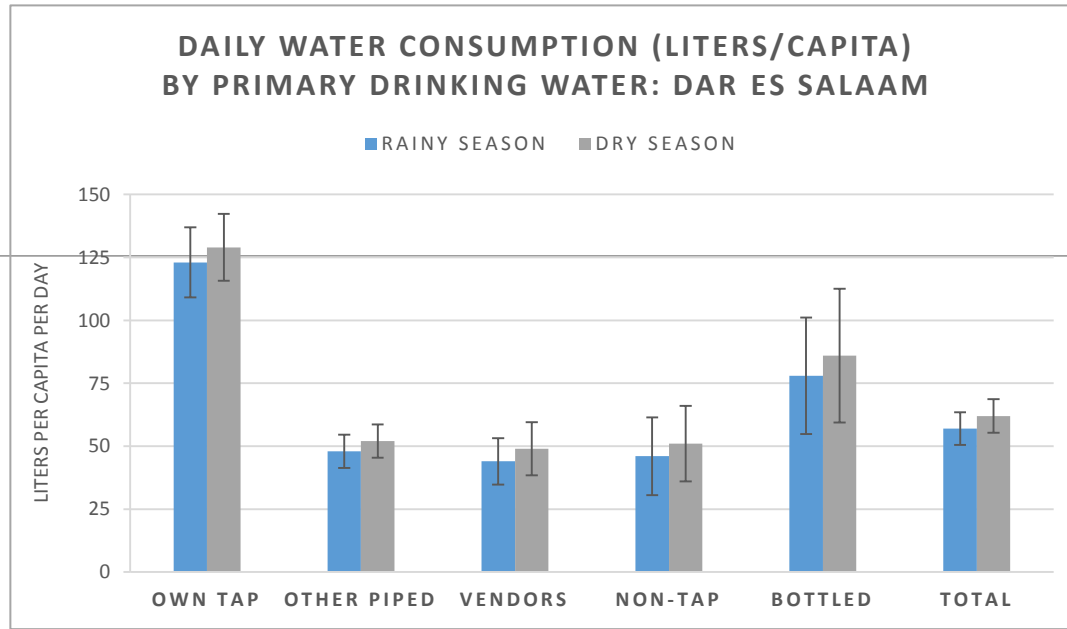
Consumption patterns of water at household level

Investment in physical and human capital

Health (diarrheal incidence among children under 5)

Water security

Water consumption (liters per capita per day)

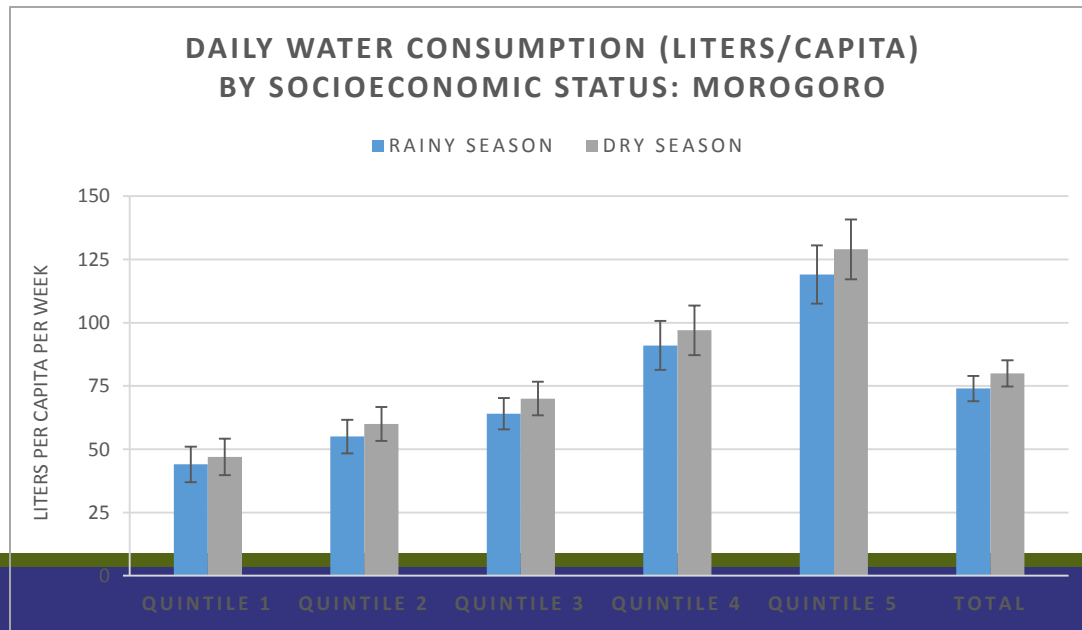
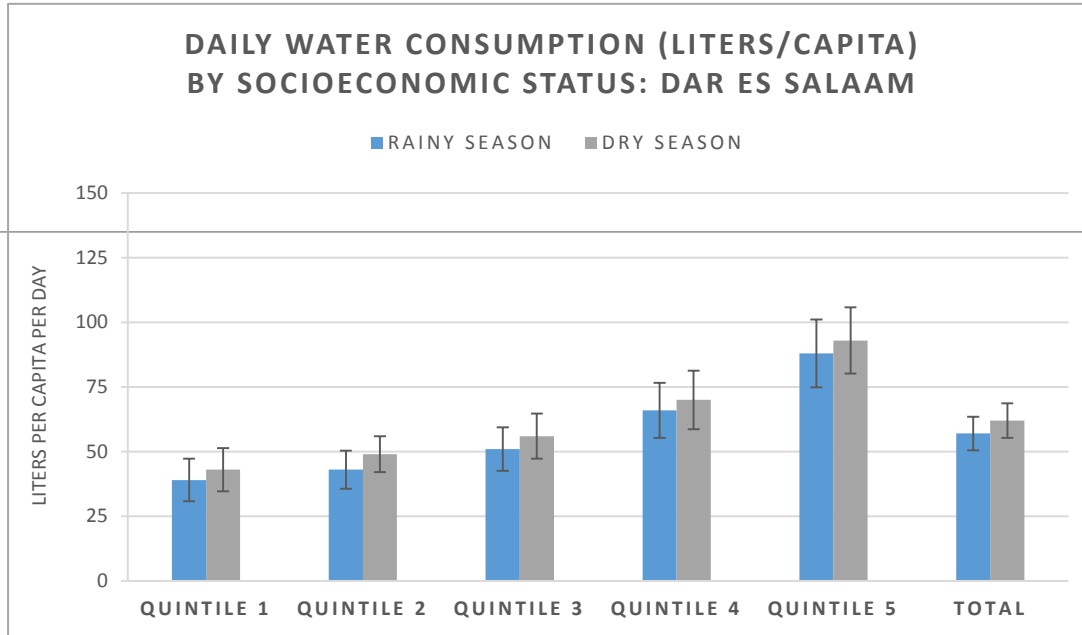


- Households using own tap for drinking and bottled water, consume more water/capita/day than those relying on other sources
- Average consumption estimates are below utility estimates (but piped water estimates similar to utility estimates)

Objectives

- Impact on:*
- Consumption patterns of water at household level
 - Investment in physical and human capital
 - Health (diarrheal incidence among children under 5)
 - Water security

Water consumption (liters per capita per day)



- Wealthier households consume more water per capita, consistent with expectations, in both cities
- Estimated elasticities of demand: own price $-.2 - -.5$, total expenditure $.3 - .5$

Objectives

Impact on:

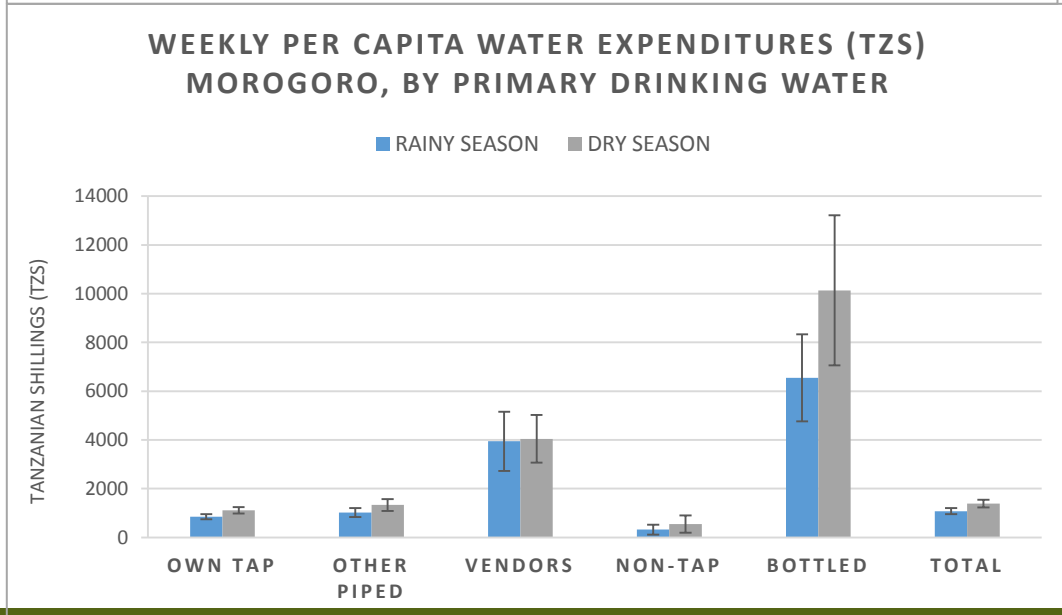
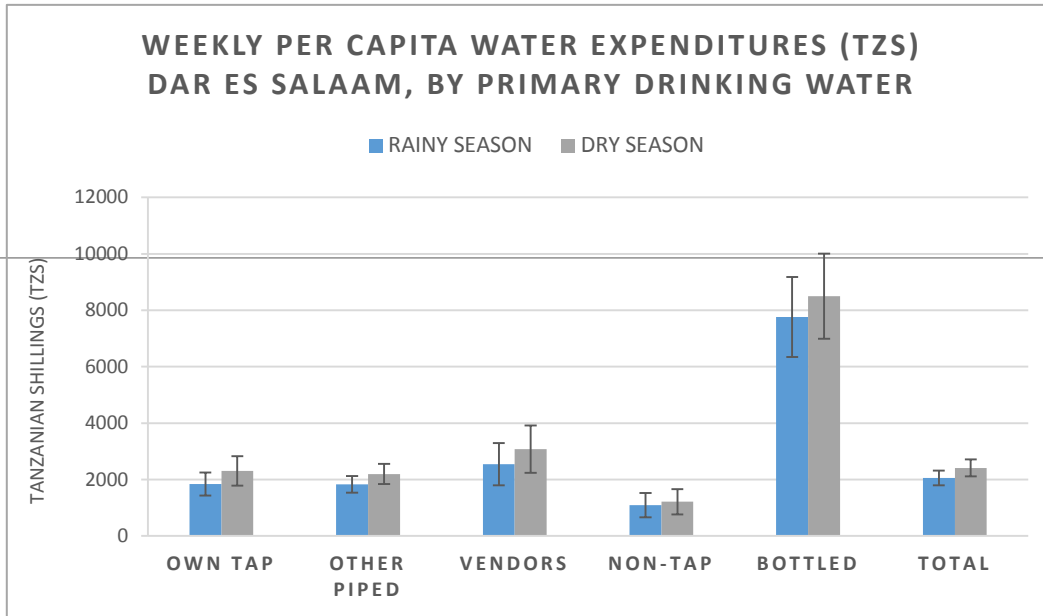
Consumption patterns of water at household level?

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Water expenditures (TZ Shillings per capita per week)

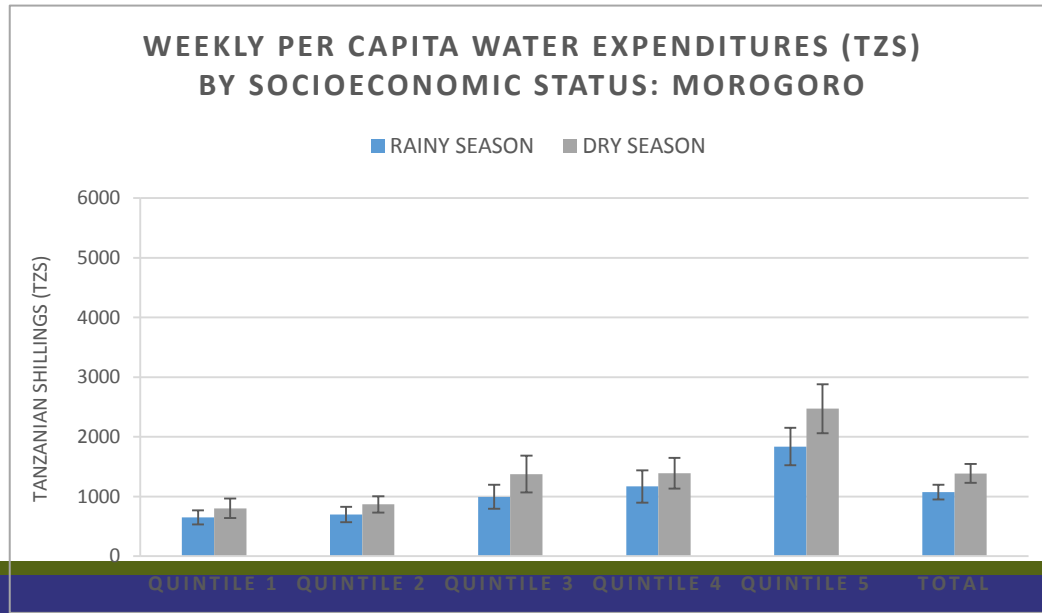
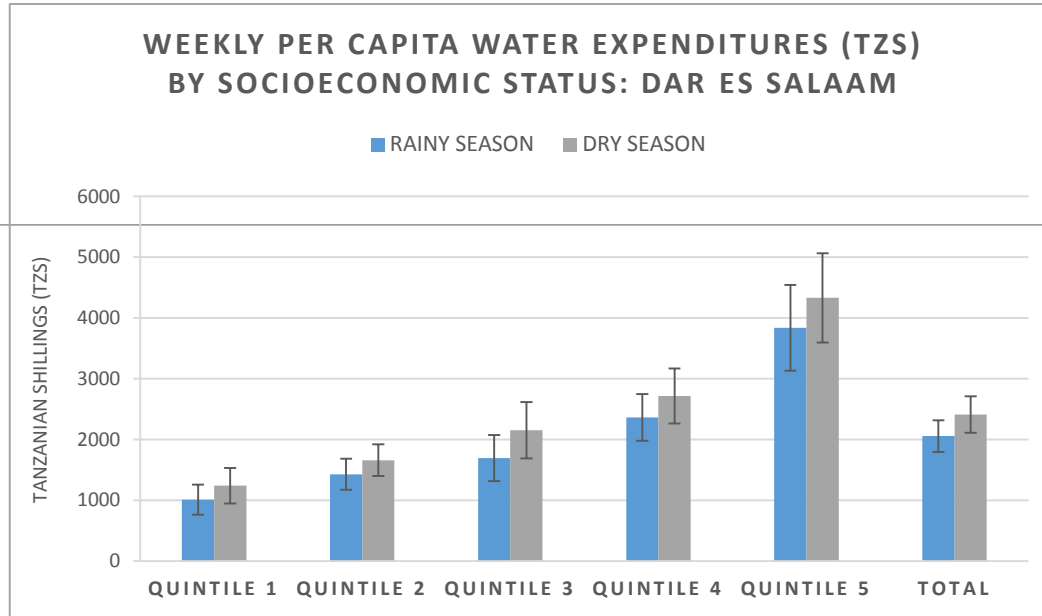


- Expenditures easier to measure from tap sources (from utility bills)
- Those using vendors pay higher prices relative to others, especially in Morogoro
- Seasonal differences are generally minimal, although expenditures slightly higher in dry season

Objectives

- Impact on:
- Consumption patterns of water at household level?
- Investment in physical and human capital
- Health (diarrheal incidence among children under 5)
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Water expenditures (TZ Shillings per capita per week)



- Daily water expenditures/capita increase with wealth
- Wealthier households have notably higher water expenditures
- Expenditures are much higher in general in Dar es Salaam
- All households groups tend to have higher expenditures in dry season

Outcomes

Impact on:

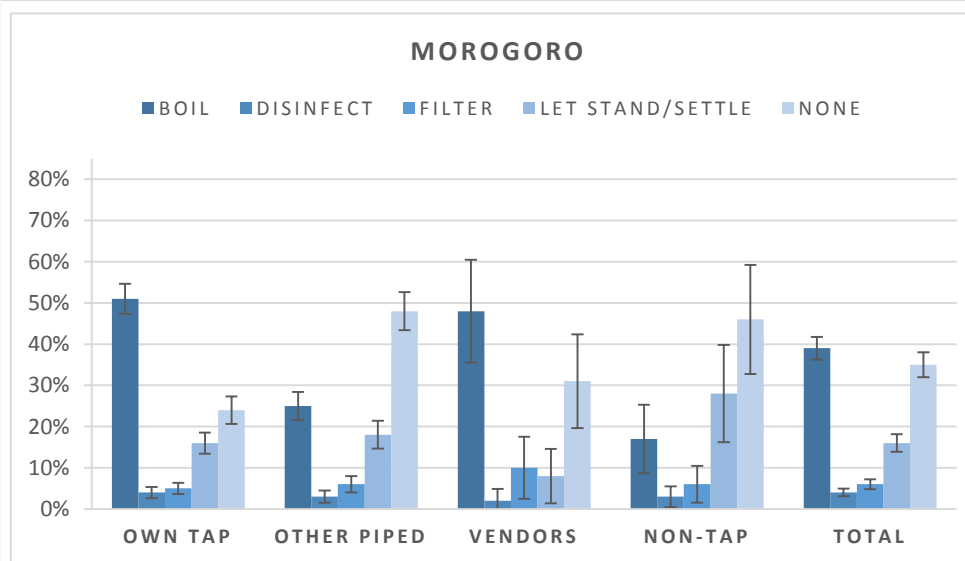
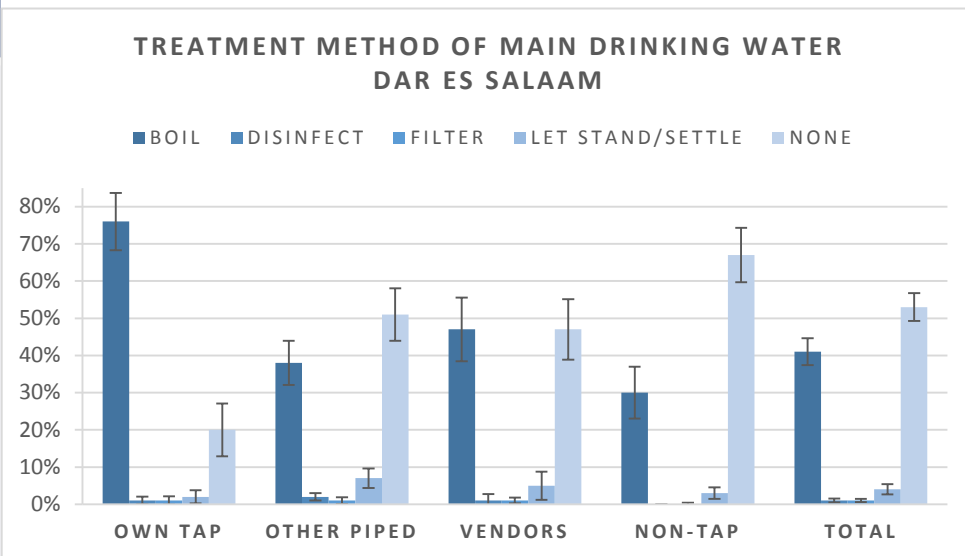
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Intervening factor: water treatment



- Tap water most likely to be treated
- Many respondents do nothing to treat water, especially from non-tap sources

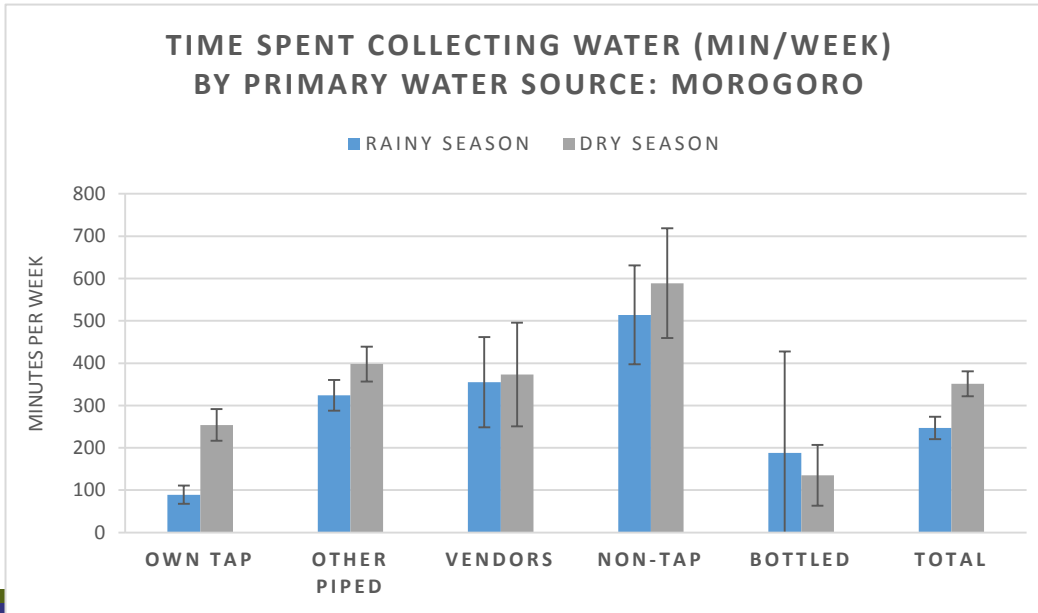
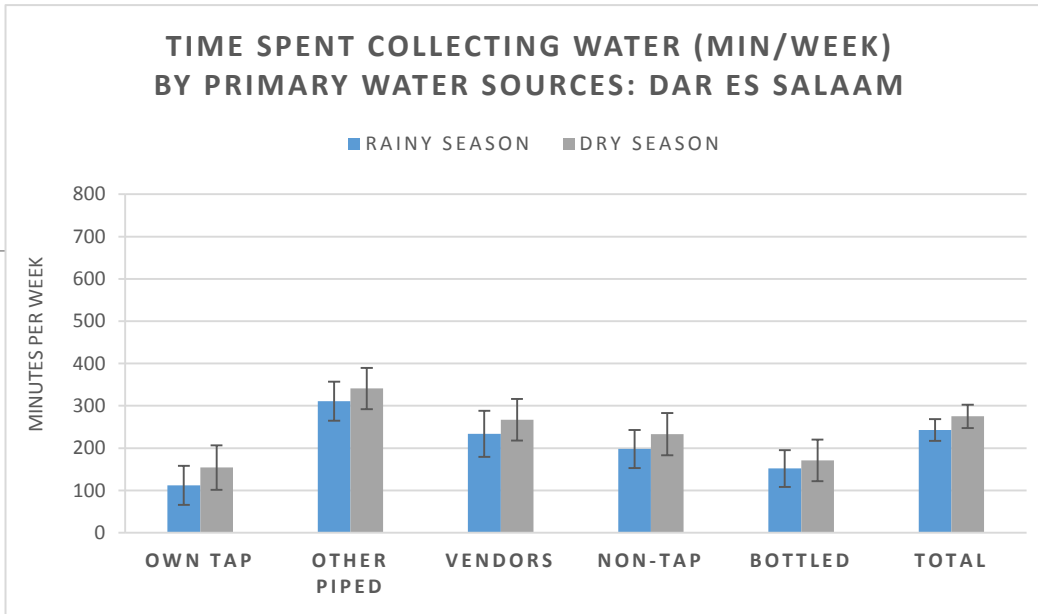
Statistical model results:

- Access to piped water increases probability of treating water by 11%
- Increased education of best-educated adult and higher SES also positively associated with water treatment

Objectives

- Impact on:**
- Consumption patterns of water at household level
 - Investment in physical and human capital
 - Health (diarrheal incidence among children under 5)
 - Water security

Time spent collecting water



- Households using another piped source for drinking spend the most time hauling water in Dar es Salaam
- Poorest households are more likely to haul water, controlling for other factors, but..
- Controlling for other factors, time spent hauling water is not related to household SES
- Time spent hauling water is highly seasonal

Objectives

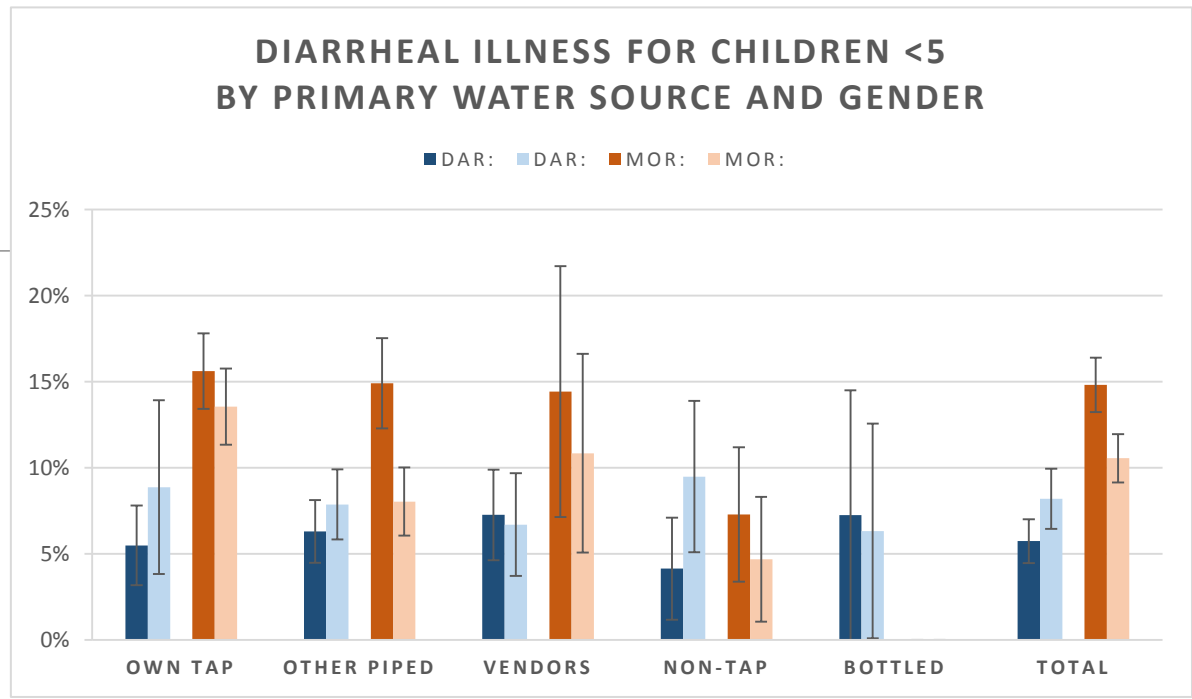
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No clear findings with regard to diarrheal illness among children under 5
(Note: estimates are very imprecise)

- Few differences observed by water source
- Rates of illness for children in Morogoro higher for all sources
- Prevalence of diarrhea low overall, reducing precision
- Regression model (probit) showed few significant variables and no relationship between illness and socioeconomic status controlling for other factors

Objectives

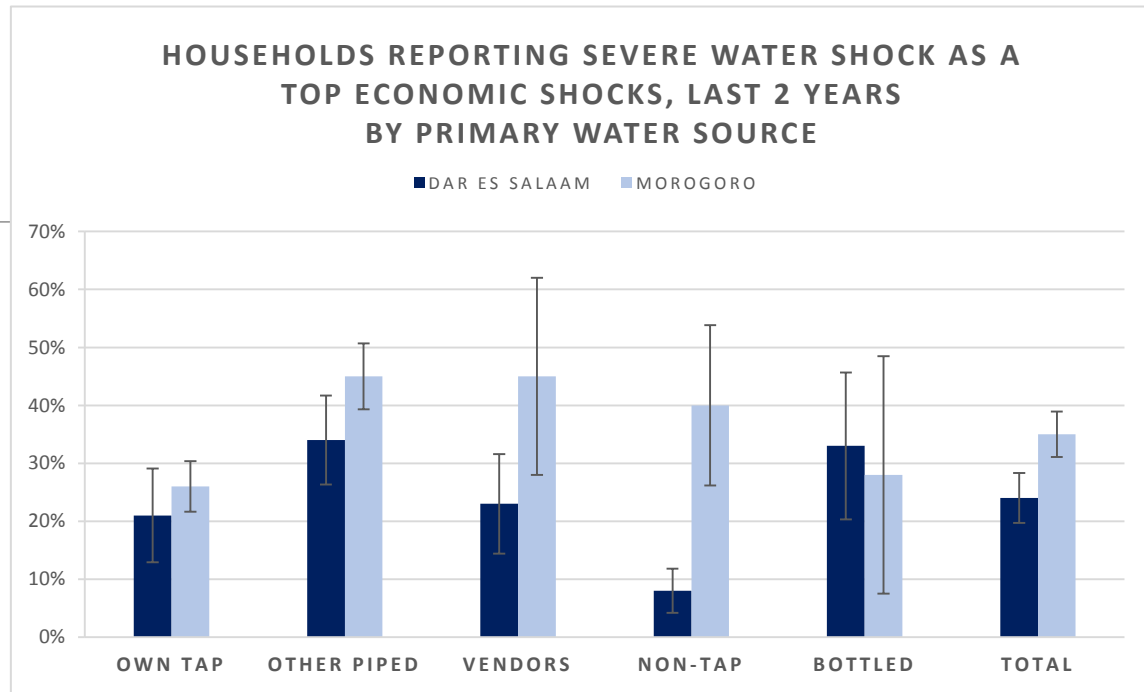
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High degree of self-reported exposure to water water shocks (water disruption among top-three shocks experienced in past five years)

- More water insecurity in Morogoro
- Use of piped water contributes to perceived insecurity
- Statistical analysis: when water is piped into dwelling, perceived insecurity increases monotonically by SES quintile; Dar es Salaam has less water insecurity

Conclusions

Large-scale intervention has potential for wide impact

- Burden of collecting water falls heavily on the poorest
- Poorest are least likely to be connected to public system and, without targeted interventions, they may benefit least

Behavioral dynamics create confounding factors (example: water treatment)

- Important to move beyond impact assessment and understand why intervention works or fails to work

Beneficiary heterogeneity argues for use of multiple methods

- Measuring “treatment” is complex
- Exposure to enhanced piped water sources affects residents in different ways

Thank you
